

# Air Force Office of Scientific Research



*18 February, 2005*

***USAF/Taiwan Nanoscience Initiative  
workshop – Honolulu, HI***

***The Basic Research  
Manager for the Air Force***

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Division

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE <b>18 FEB 2005</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>The Basic Research Manager for the Air Force</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Air Force Office of Scientific Research 875 N. Randolph St., Suite 325, Arlington, VA 22203-1768</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES <b>See also ADM201995., The original document contains color images.</b>					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>29</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			



# Welcome to Hawaii



- **The Hawaiian Islands were discovered by:**
  - **Blue Whales a very long time ago**
  - **Polynesian explorers a long time ago**
  - **By Captain Cook, RN in 1778**
  - **By Jack Agee in 1973**
- **We enjoy the Hawaiian traditions of Aloha – welcome to a beautiful and friendly place**
- **We are on Oahu, which throughout recorded history ha been the meeting place**
- **The future is bright! – Nanoscience is part of the reason**

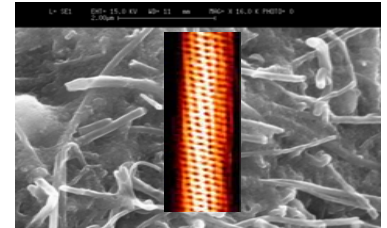


# NANOTECHNOLOGY FOCUS AREAS AT AFOSR



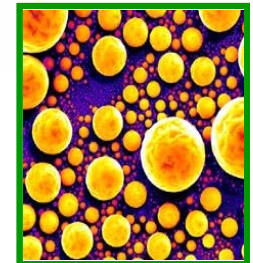
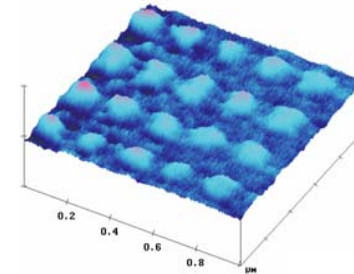
## HIGH PERFORMANCE MATERIALS

- *high temperature*
- *high strength*
- *light weight*
- *smart*
- *multifunctional*



## INFORMATION PROCESSING

- *nano-electronics/nano-magnetics*
- *nano-photonics & nano-optics*



## ENERGETIC MATERIALS

## COMPACT POWER GENERATION AND STORAGE

## BIO-INSPIRED CONCEPTS

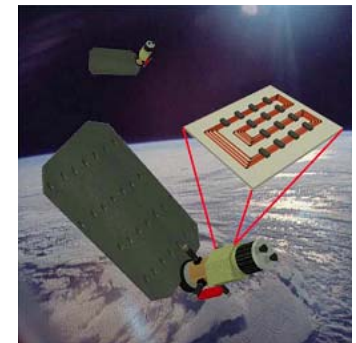
## PREDICTIVE TOOLS

- *molecular dynamics*
- *quantum computing*

## MATERIALS PROCESSING & FABRICATION

## NANOPROBE TOOLS

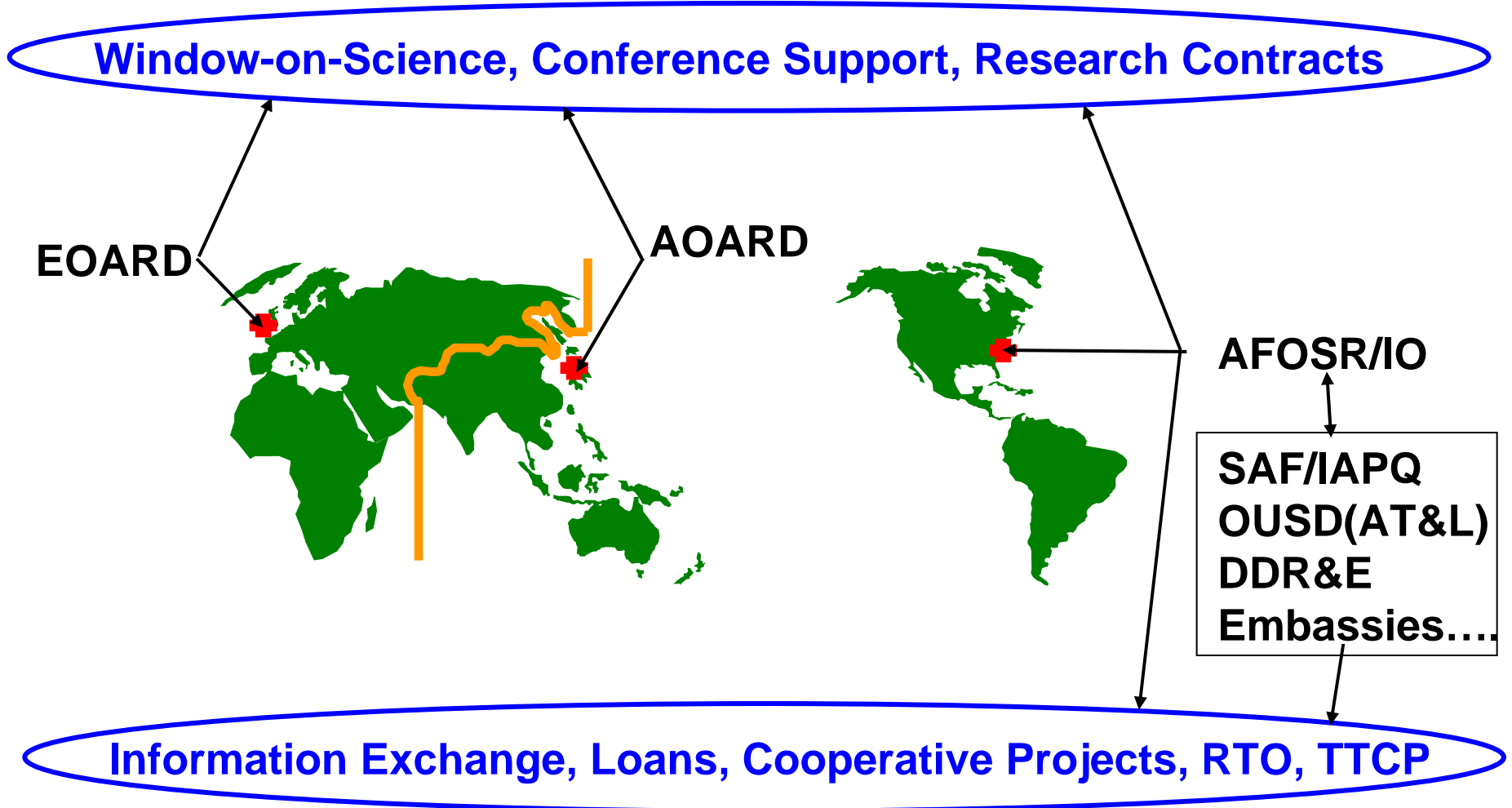
## SURFACE MODIFICATION





# International Programs

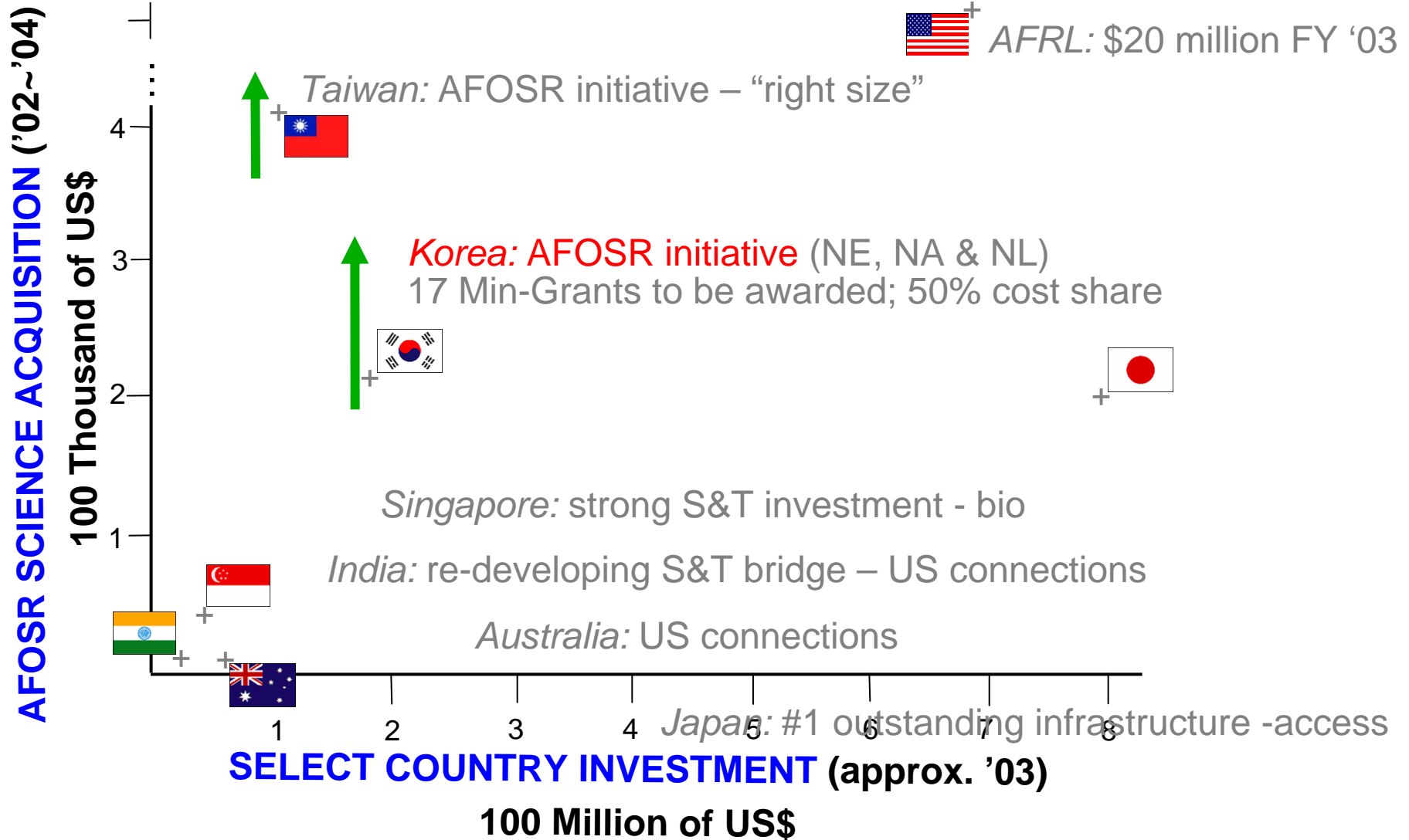
## Non-Government Interaction



## Government-to-Government Cooperation



# INVESTMENT IN NANOSCIENCE & MICROSYSTEMS



Ave. FY'03 international overhead: 13% Direct & indirect leverage: >>> \$ millions



# Taiwan – AFOSR Nanoscience Initiative



- Natural extension of common interest
- Founded in recognition of Taiwan's commitment to establishing itself as a world-class technical power in nanoscience and nanotechnology
- Primary goal: To establish mutually beneficial scientific interactions between researchers in Taiwan and AFRL scientists
  - Foster basic research innovation & interactions between scientists
  - Enhance future USAF capabilities through support of Air Force fundamental nanoscience research efforts

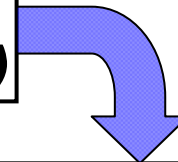




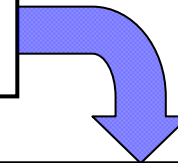
# Taiwan/Air Force Program Concept



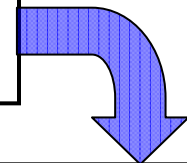
**AFOSR Requests  
White Papers (2 pages)**



**AFRL & AFOSR Reviews  
White Papers**



**Select / Make Request for  
Full Proposal**



**Select Proposals and  
Award Contracts**

## Key Program Elements

- Visits and Joint Workshops
- Research Funding
- Sponsorship of In-Country Conferences

**Hold Periodic Joint  
Technical Exchange  
Meetings**



USAF – TW Joint Workshop, Maui, Feb 2004





# Taiwan Participants Include



- **National Science Council**
- **Academia Sinica**
- **Chung-Shan Institute of Science and Technology**
- **Industrial Technology Research Institute**
- **National Cheng Kung University**
- **National Chiao Tung University**
- **National Chung Cheng University**
- **National Taiwan University**
- **National Taiwan Normal University**
- **National Tsing Hua University**





# Closing Thoughts



- **The Air Force Office of Scientific Research works within the Air Force Research Laboratory to Enhance Scientific Research**
  - Among world class researchers
  - With Universities, Industry, Government Laboratories
- **Nano Science and Technology R&D a Major Contributor to Revolutionary System Capabilities**
- **Globalization of Research & Development is Key**
  - Asian Office of Research and Development, Tokyo
  - Benefits are win-win for the USAF and for our international partners



# Back-Up Charts





# Taiwan Projects in Materials Area



- **034017, *Investigation on Mechanical Properties of Nano-scale Thin Film*, Yeau-Ren Jeng, National Chung Cheng University**
- **034021, *Diamond-Like Carbon (DLC) Nanocomposite Film Depositions and Characterizations*, Franklin Chau-Nan Hong, National Cheng Kung University**
- **034040, *Growth and Characterization of Nanorods*, Jih-Jen Wu, National Cheng Kung University**
- **034054, *The Relationship of Microscopic Material Characteristics & Physical Behavior of Quantum Dots*, Shan Torng, Chung-Shan Institute of Science & Technology**
- **044026, *InGaN/GaN Quantum Dots --- Growth, Nano-structure Material Analysis, and Optical Characterization*, Chih-Chung Yang, National Taiwan University**
- **044073, *Study of Laser Ablation for Generating Nano-Particles*, Jehnming Lin, National Chen Kung University**
- **044074, *Dispersion and Reinforcement of Nanotubes in High Temperature Polymers for Ultrahigh Strength and Thermally Conductive Nanocomposites*, Arnold Chang-Mou Yang, National Tsing Hua University**



# Taiwan Projects in Devices Area (1)



- **024004, *THz Laser based On Ge/Si Heterostructures*, Hung Hsiang Cheng, National Taiwan University**
- **024046, *Polymer Based Field-Effect Transistors*, Ten-Chin Wen, National Cheng Kung University**
- **024052, *Blue Laser Gain Characteristics of InGaN Quantum Dots Embedded in InGaN Quantum Well Structures*, Chih-Chung Yang, National Taiwan University**
- **034019, *Integrated Field Emission Devices Based On Carbon Nanotubes and Related Nanostructures*, Li-Chyong Chen, National Taiwan University**
- **034020, *Study on Wide-Gap Gallium-Nitride Based Films and Their Quantum-dots Devices*, Huey-Liang Hwang, National Tsing Hua University**



## Taiwan Projects in Devices Area (2)



- **044020, *THz laser based on Si*, Hung Hsiang Cheng, National Taiwan University**
- **044025, *Novel Organic Field Effect Transistors via Nano-Modification*, Ten-Chin Wen, National Cheng Kung University**
- **044070, *GaN/AlGaN Terahertz Quantum Cascade Laser*, Shing-Chung Wang, National Chiao Tung University**
- **044071, *Study on Wide-gap Gallium-nitride Films and Their Quantum dots Devices*, Huey-Liang Hwang, National Tsing Hua University**
- **044072, *Ge/SiGe Quantum Dot Detectors and Light Sources at Terahertz Frequencies*, Cheewee Liu, National Taiwan University**



# Taiwan Projects in Bio-Nano, Energy



- **Bio-Nano**
  - **044008, *High resolution real time phase contrast radiology study of hydrodynamic in micrometer scale*, Maw-Kuen Wu, Academia Sinica**
- **Energy**
  - **044023, *High Efficiency Photovoltaic Devices Fabricated from Self-Assemble Block Insulating-Conducting Copolymer Containing Semiconducting Nanoparticles*, Wei-Fang Su, National Taiwan University**
  - **024048, *High Efficiency Photovoltaic Devices Fabricated from Self-Assemble Block Insulating-Conducting Copolymer Containing Semiconducting Nanoparticles*, Wei-Fang Su, National Taiwan University**





# Taiwan Projects in Foundational Areas



- **Self-Assembly (foundation)**
  - **034018, *Self-Assembly of Block Copolymer/Quantum Dot Nanocomposites for Optical Application*, Kung-Hwa Wei, National Chiao Tung University**
  - **044069, *3D Photonic Crystals Build Up By Self-Organization Of Nanospheres*, Yu-Wen Chen, National Central University**
- **Modeling and Simulation (foundation)**
  - **034039, *Fundamental study on quantum nanojets– structures, dynamics and energetic*, Huei-huang Chiu, National Cheng Kung University**



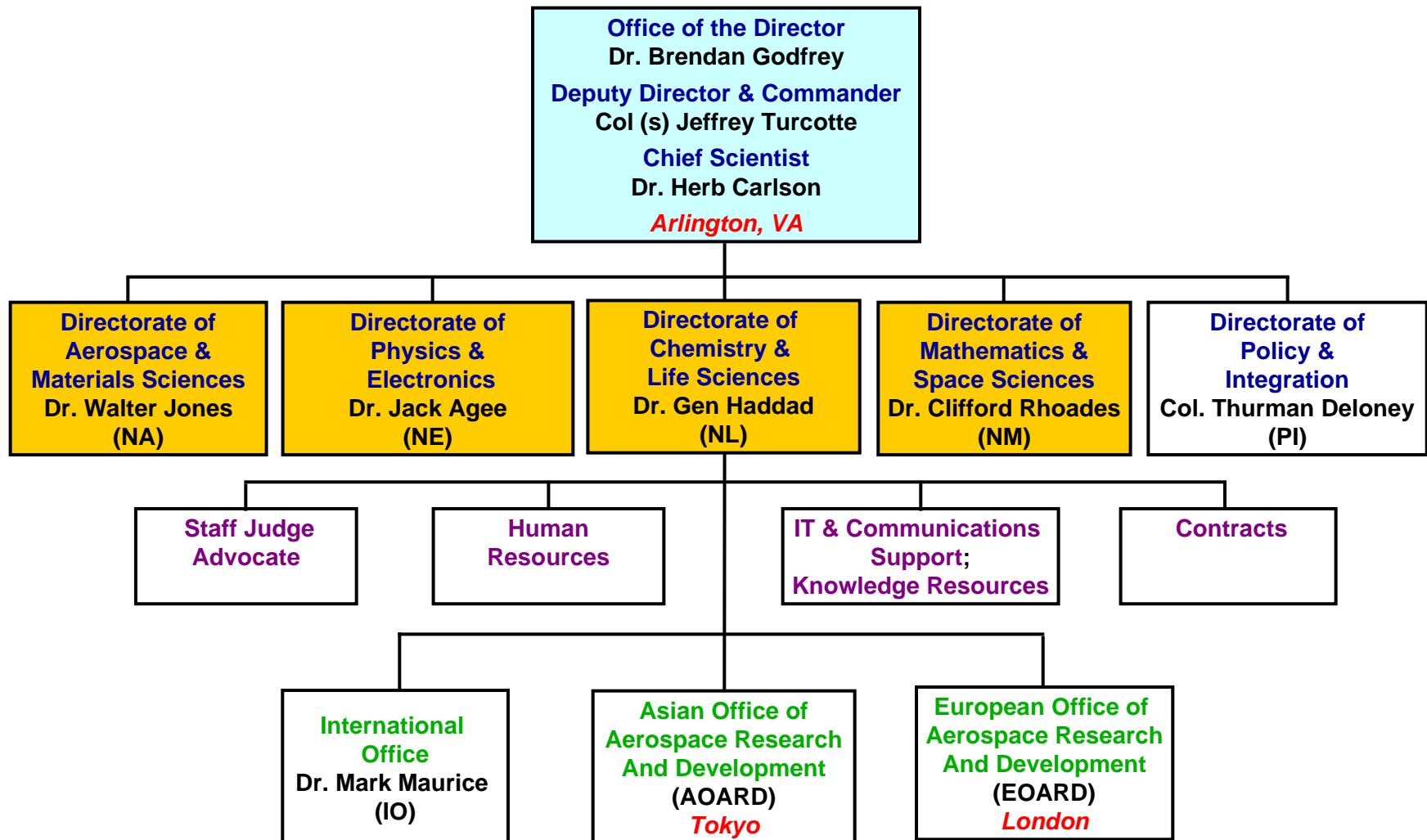
# CSIST Nanoscience Contract



- **AFOSR Contract with CSIST Researcher**
  - **Relationship of Microscopic Material Characteristics & Physical Behavior of Quantum Dots**
  - **Dr. Shan Torng (CSIST)**
  - **Explore relationship between microscopic materials characteristics and physical behavior for self-organized InAs/GaAs quantum dots, including quantum effect and optical properties**

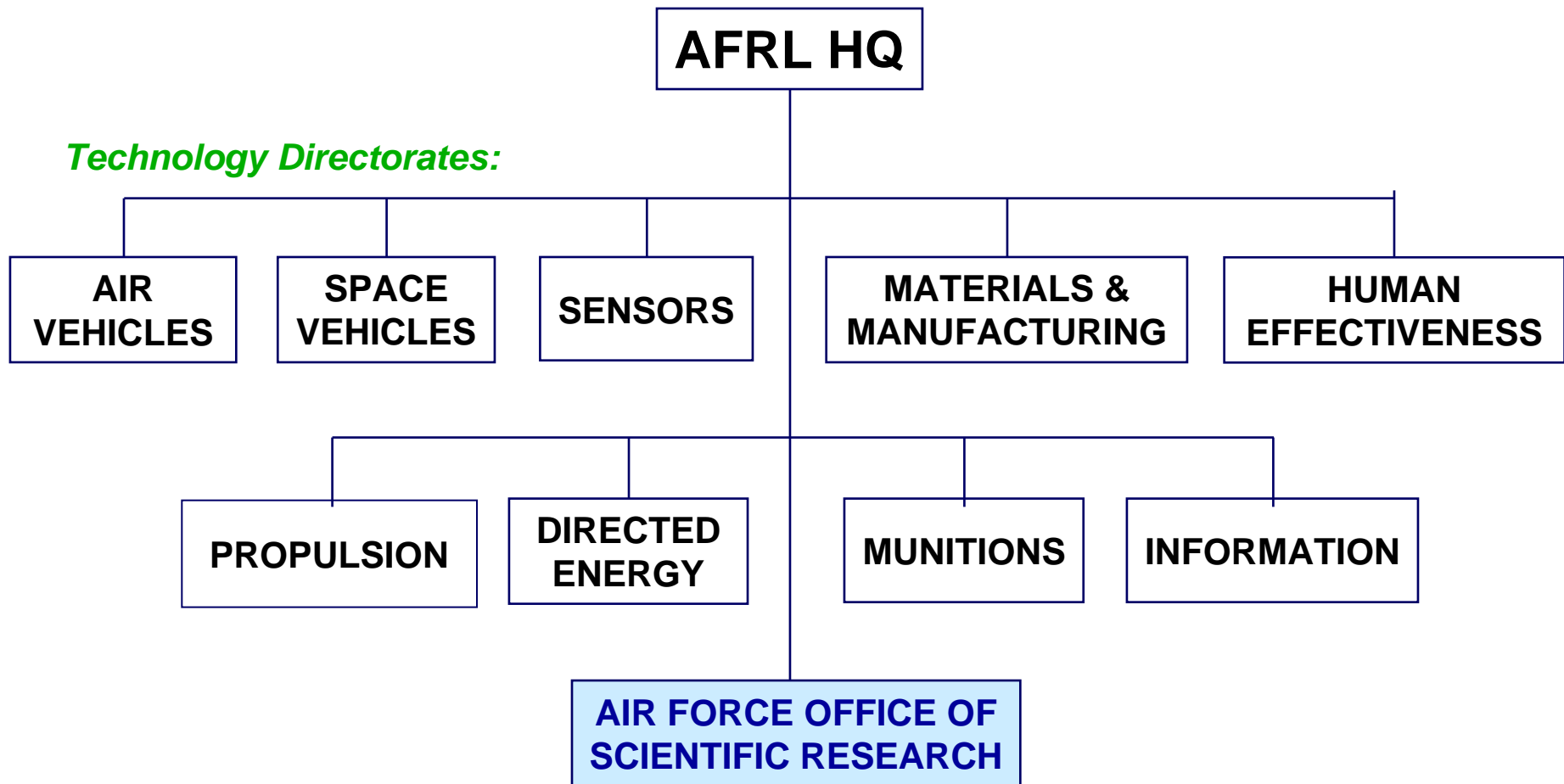


# AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)





# AIR FORCE RESEARCH LAB (AFRL)



*Sole Manager of AF Basic Research*



# **AFOSR PROGRAMS WITH NANOTECHNOLOGY FOCUS**



**Program (Program Manager):**

**Semiconductor Materials** (*Steiner*) <<

**Optoelectronics/Nanophotonics** (*Pomrenke*)

**Quantum Electronic Solids** (*Weinstock*)

**Molecular Dynamics** (*Berman*)

**Surface & Interfacial Science** (*Trulove*)

**Polymers/Polymer Composites** (*C. Lee*)

**Ceramic & Nonmetallic Materials** (*Fuller*)

**Metallic Materials** (*Hartley*)

**Mechanics of Materials/Devices** (*B. L. Lee*) <<

**Biomimetics** (*DeLong*)



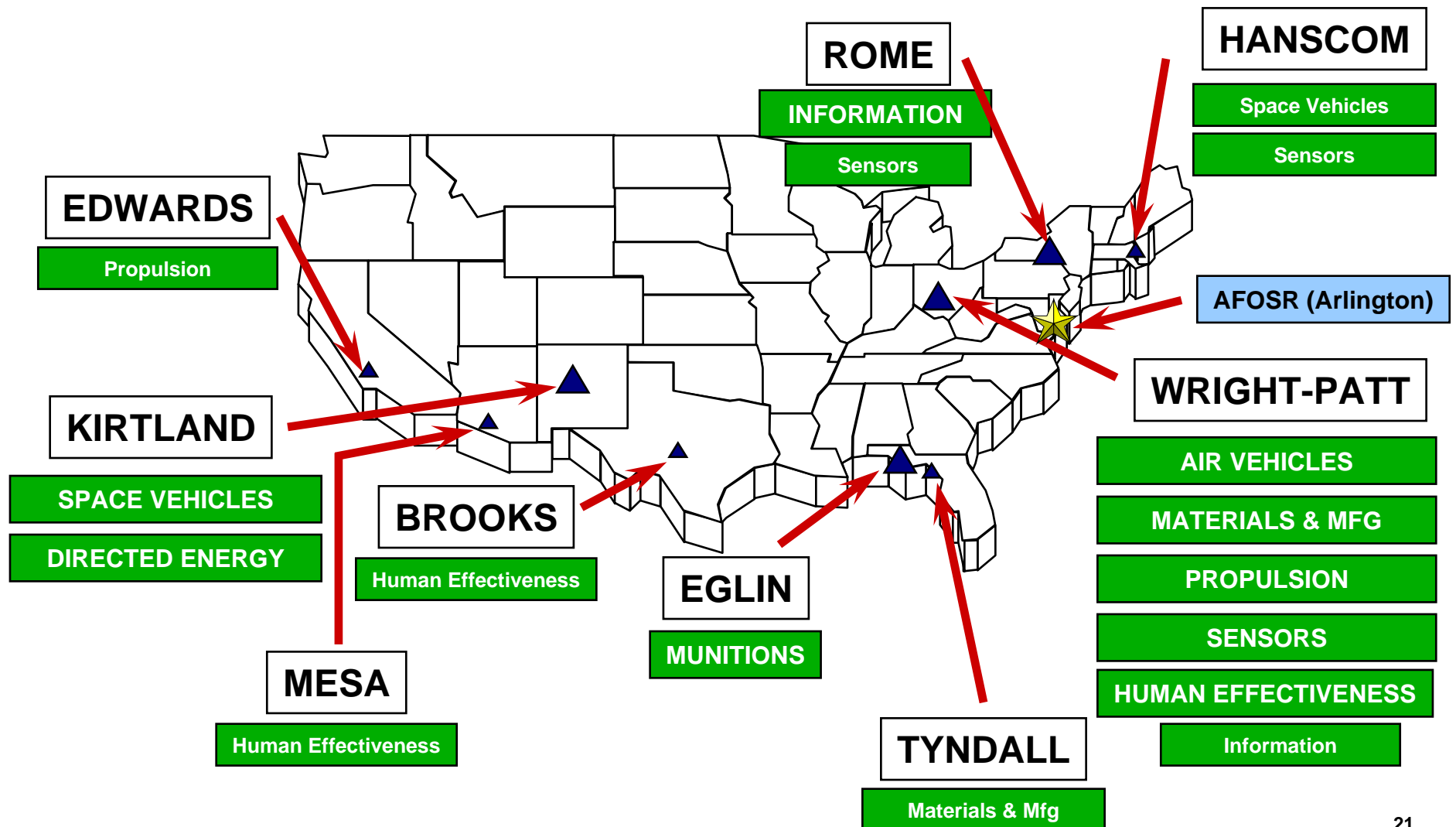
# Overview of AFRL NST Interest



- **Materials Area**
  - 1. Tailorable Dielectrics
  - 2. Reconfigurable Optical Response
  - 3. Adaptive Structural Materials
  - 4. Thermal Control Materials
- **Energy Area**
  - 5. Energetics on the Nanoscale
  - 6. Nano-enhanced Power Technologies
- **Devices Area**
  - 7. Quantum Confined Optical Sensors
  - 8. Nanotechnology for RF
  - 9. Nano Signal Processors
- **Bio-Nano Area**
  - 10. Bio Interactions of Nanostructures
- **Cross-Cutting (foundations)**
  - 11. Self-assembly of Nanostructures
  - 12. Nano-Micro-Macro Interfaces
  - 13. Modeling And Simulation



# AFRL RESEARCH SITES





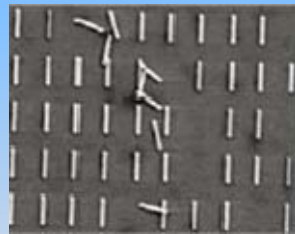


# Nano Science & Technology Application



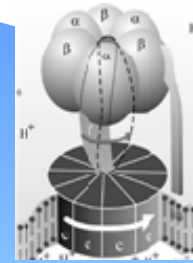
## Generations

Fourth: Molecular  
Third 3D  
Second: Active  
First: Passive



## NanoTechnologies

NanoMachines  
NanoDevices  
NanoEngineering



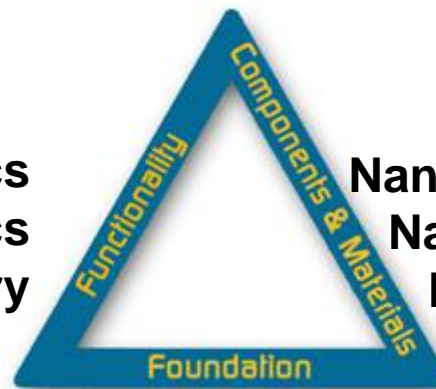
## Nano-Enhanced Technologies

Coatings  
Catalysts  
Structures  
Power  
Generation



## NanoScience

NanoElectronics  
NanoMagnetics  
NanoChemistry  
NanoPhotonics



NanoStructures  
NanoParticles  
NanoComposites

NanoMetrology NanoFabrication  
NanoAssembly Theory&Modeling



# Nanoscience Initiative Chronology



- Oct 01: AFRL Introduction to TECRO
- Feb 02: High Level AFOSR Delegation to Taiwan, [incl. CSIST](#)
  - AFOSR Commander, Chief Scientist, Dir of Phys & Electronics
- Apr 02: AFRL-Taiwan Nanoscience Research Opportunities Seminar (Joint Workshop)
- Aug 02: Visit to Researchers & NSC by AFOSR, AOARD
- Sep 02: High Level Delegation Visit to Taiwan
  - Included AFOSR Director, AFRL Chief Technologist
- Aug 03: AOARD Visit to Researchers
- Nov 03: Visit to Universities, [CSIST](#), & NSC by AFOSR, AOARD
- Feb 04: Joint US Air Force/Taiwan Nanoscience Initiative Workshop, Maui HI

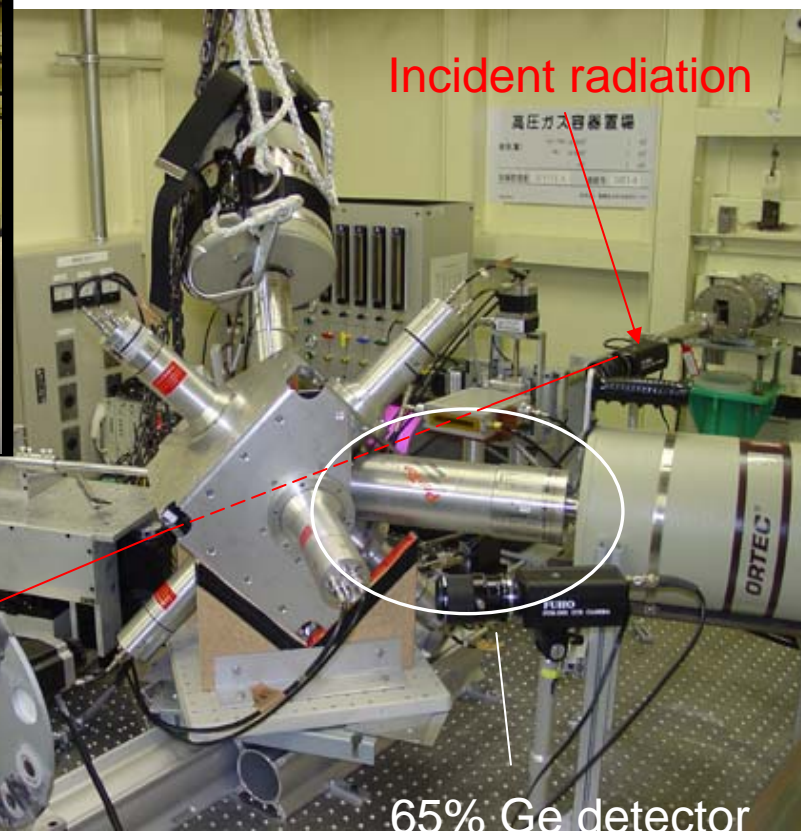
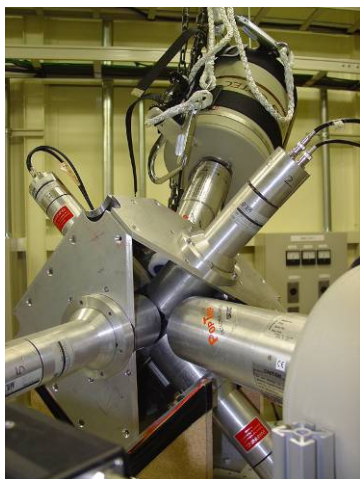
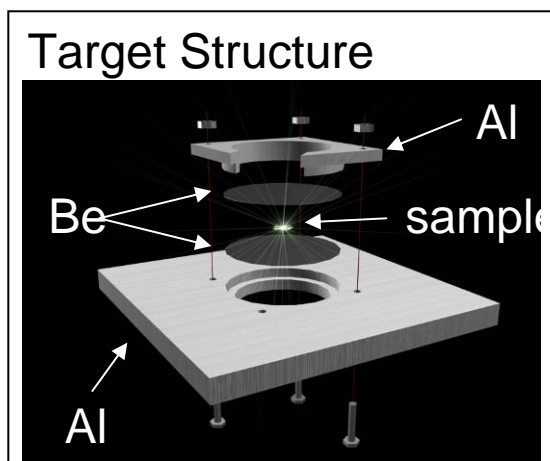


# Taiwan Projects by Area



- **Materials**
  - 7 projects
- **Devices**
  - 10 projects
- **Bio-Nano**
  - 1 project
- **Energy**
  - 2 projects
- **Self-Assembly (foundation)**
  - 2 projects
- **Modeling and Simulation (foundation)**
  - 1 project

## *TYPICAL EXPERIMENTAL SETUP (YSU MINIBALL ARRAY)*



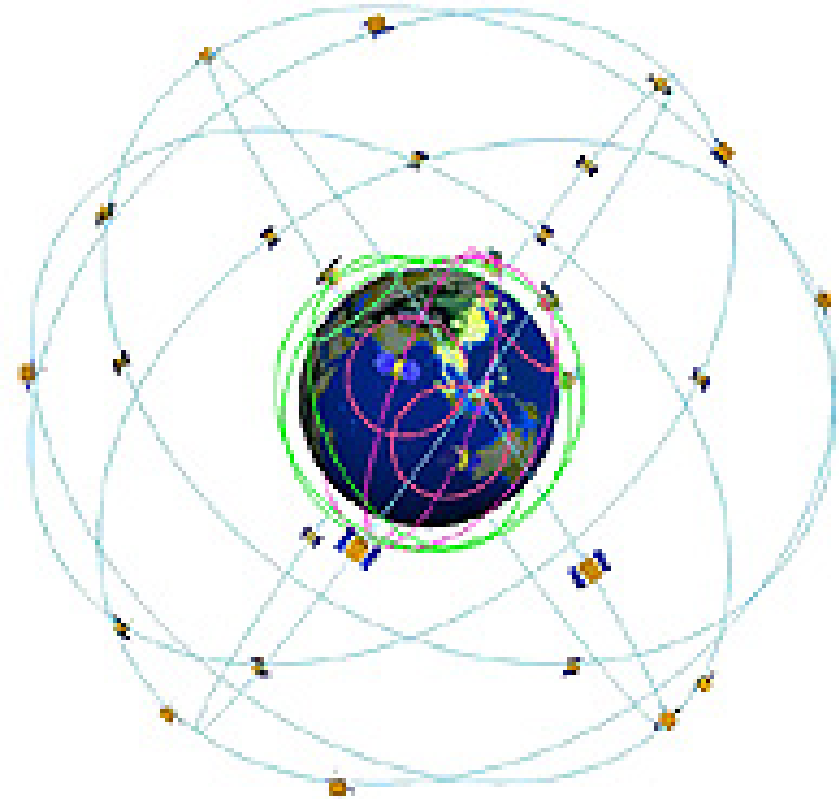
Target positioning arm



# ROCSAT-3 Mission

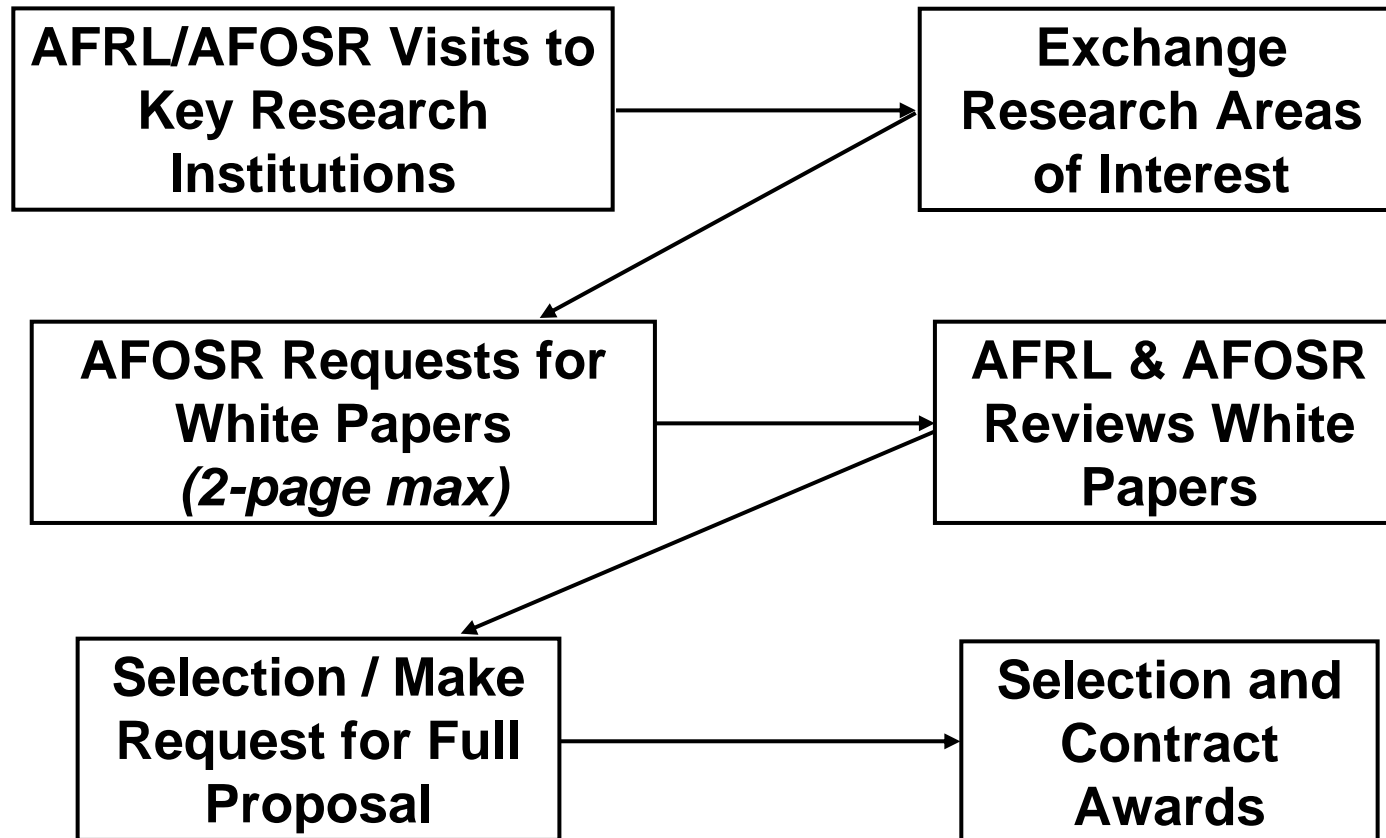


- The ROCSAT-3/COSMIC program is to launch and operate a constellation of 6 LEO micro-satellites comprised of an integrated spacecraft platform and three payloads
  - GPS occultation receiver
  - Tiny Ionosphere Photometer
  - Tri-Band Beacon Transmitter
- These micro-satellites will collect a large amount of atmospheric data for meteorological, climatic, ionospheric, and geodetic research as well as for weather forecasting and space weather monitoring





# South Korea / Air Force Program



**Hold Periodic Joint Technical Exchange Meetings**



# US - South Korea Collaboration



- **AFOSR Directors and Program Managers**
  - Manage investments in basic research
  - Have portfolios of research efforts
- **AFRL Technical Directorates and AFOSR**
  - Create / influence international projects
- **International Office**
  - Coordinate issues - cooperative efforts / MOUs
- **AOARD**
  - Make **Windows On Science** visits happen
  - Arrange for meetings
  - Put in place **Mini-Grants** in areas of mutual interest





# Air Force Basic Research Program



- **The Nanoscience and Technology Program is Collaboratively Planned by AFOSR Program Managers and AFRL In-House Researchers**
- **The Basic Research Effort is Closely Coordinated with Applied Research and Demo Efforts**
- **NST Basic Research Leverages Extensive International Investments**

**The South Korea – AFOSR Nanoscience Initiative is a Model for International Research**